

Original research

Self-rated health and oral health in type 2 diabetic patients – a case-control study



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ABSTRACT

Objectives: To analyze whether there are differences between self-rated general health (SRH) and self-rated oral health (SROH) between individuals with type 2 diabetes mellitus (DM2) and without DM2, and to explore the general and oral conditions associated with major impacts on general health (GH) and oral health (OH) self-perception.

Methods: After obtaining ethical approval and informed consent, the sample included 343 DM2 patients (DM2 group) and 323 controls (nDM2 group), all adult volunteers. Data was obtained from clinical records and oral health examination, using WHO criteria and a questionnaire to rate their own GH and OH on a Likert 5-point scale. Inference analysis was conducted using parametric and non-parametric tests and logistic multivariable regression (MLR) ($\alpha=0.05$).

Results: DM2 patients' perception of own GH was significantly worse than nDM2's ($p<0.001$). The MLR showed that the risk factors for a worse perceived GH were calculus and oral hygiene at night in nDM2, and HTA, dyslipidaemia and at least one missing tooth in DM2. Both SRH and SROH were significantly ($p<0.001$) often classified as "bad" or "very bad" in DM2. Calculus and pockets ≥ 4 mm were identified as increased risk factors (OR=3.55, $p=0.049$; OR=4.32, $p=0.025$, respectively) and DMFT>0, calculus and gingival recession were associated ($p<0.001$) with "bad" or "very bad" SRH and SROH in the MLR.

Conclusions: Individuals with type 2 diabetes mellitus showed a worse self-perception of own general health and oral health than individuals without this pathology, and oral health was generally self-rated worse than general health. (Rev Port Estomatol Med Dent Cir Maxilofac. 2018;59(4):181-190)

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Auto-avaliação de saúde e saúde oral em pacientes diabéticos tipo 2 – estudo caso-controle

R E S U M O

Palavras-chave:

Estudo caso-controle
Cuidados de saúde primários
Autoavaliação da saúde
Autoavaliação da saúde oral
Diabetes tipo 2

Objetivos: Verificar existência de diferenças entre a autoavaliação da saúde geral (SRS) e da saúde oral (SROH) entre pacientes com diabetes *mellitus* tipo 2 (DM2) e sem (nDM2) e explorar as condições de maior impacto na saúde geral (GH) e oral (OH) associadas à autopercepção.

Métodos: Após aprovação ética e consentimento informado, obteve-se 343 adultos DM2 e 323 controlos. Os dados clínicos e de OH foram coletados usando critérios da OMS e perguntas para autoclassificação de GH e OH numa escala de Likert (5 pontos). A análise inferencial utilizou testes não-paramétricos e regressão logística multivariada (MLR) ($\alpha=0,05$).

Resultados: Os pacientes DM2 autoavaliam significativamente pior a sua GH do que nDM2 ($p<0,001$). Nos nDM2, a MLR mostrou que cálculo e higiene oral à noite são fatores de risco para uma percepção de pior GH; entre os DM2 é a HTA, dislipidemia, ≥ 1 dente ausente. Para os DM2, a SRH e SROH, mostra significativamente ($p<0,001$) mais frequente as percepções de “má” ou “muito má”. O cálculo e bolsas ≥ 4 mm foram identificadas como fatores de risco (OR=3,55, $p=0,049$; OR=4,32, $p=0,025$, respetivamente) e CPOD >0 , presença de cálculo e recessões estão associadas ($p<0,001$) a mais frequente percepção como “má” ou “muito má” SRH e SROH.

Conclusões: Indivíduos com diabetes *mellitus* tipo 2 mostraram uma pior autopercepção de saúde geral e oral do que os indivíduos sem esta patologia e a saúde oral foi pior autoavaliada que a saúde geral. (Rev Port Estomatol Med Dent Cir Maxilofac. 2018;59(4):181-190)

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Introduction

Oral health (OH) is one of the domains of general health (GH). Both are related to personal well-being, which includes functional capacity, physical wellness, emotional stability, and social-familial interactions.¹ Personal well-being also depends on the perception of disease and the way individuals understand several aspects related to health and disease, considering their individual and social experiences, including their knowledge about their pathology,² symptoms, potential causes, probable duration, evolution in time and potential consequences.³ OH is multi-faceted and includes the abilities to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and any disease of the craniofacial complex.⁴

Diabetes mellitus is associated with significant multi-morbidity and affects about 422 million individuals worldwide, a number that is increasing.^{5,6} Because diabetes mellitus type 2 (DM2) is a chronic disease, the health status of the affected individuals tends to degrade over time, with the arising of clinical complications mostly due to an increasingly difficult glycaemic control. The development of comorbidities leads to a depreciation of the perceived quality of life.⁷ Oral pathology is one of the major complications in DM2 patients and, therefore, it is important to intervene early in order to reduce the risk of a future interaction between these pathologies.⁸⁻¹¹

The emphasis on similarities between determinants of OH and GH is broadly consistent and leads to the conclusion that

OH is an integral part of GH.¹² Some studies have identified associations between oral pathology and DM2,^{1,8,13,14} and both are associated with a worse perceived GH¹⁵ and worse oral health quality of life due to OH manifestations.¹⁶⁻¹⁸

The self-perception of health (SPH) is a subjective indicator that complements the clinical health status, independently of medical interpretations of signs and symptoms, and has been identified as an important predictor of mortality or health care. The SPH is a valid assessment of the individual's GH and OH perception¹⁹⁻²² and can be used as a predictor of future health outcomes^{23,24} or related to OH in diabetic patients.²⁵⁻²⁹ The self-perception of impacts on both GH and OH is not always significantly valued in literature,^{1,30-32} and it can be theorized that the association between the individuals' perception of OH and GH is not always clear.³³

This study aims to analyze whether there are differences between self-rated general health (SRH) and self-rated oral health (SROH) between individuals with DM2 and without DM2 and to characterize the general and oral conditions associated with general-health and oral-health self-perception.

Material and methods

A case-control study was conducted among adult volunteers with DM2 and without DM2 attending a primary healthcare centre – the Family Health Unit (FHC) of Espinho, Portugal. Ethical clearance (*Parecer* CES/ARSN n.8/2013) was obtained from

the Ethical Board of the Portuguese Northern Regional Health Administration. The permission to examine the patients' mouth and record the data was obtained from authorities.

Adult volunteers attending the FHC were randomly invited to participate by telephone. For those who accepted, an appointment including oral examination was performed to evaluate if they met the inclusion criteria. Patients with DM2 were invited for the disease group of the study (DM2 group) and healthy volunteers with no DM2 diagnosis for the control group (nDM2 group).³⁴ The pairing mode between cases and controls was partially performed based on gender and age.

A sample size of at least 656 individuals (328 in each group) was calculated for an expected prevalence of dental caries of 65%±5%, an expected difference of 5%, a 95% CI and a power of 90%, based on the III National Study's results on the prevalence of dental caries in adults.³⁵

Data on haemoglobin A1c (HbA1c), body mass index (BMI), duration of illness and presence of complications were obtained by consulting the individual electronic or paper clinical process. The clinical analytic data considered was the last one available in the 12 months prior to the interview.

The oral-health status was recorded following the WHO oral health criteria³⁶ through a questionnaire and clinical evaluation. The questionnaire was administered face-to-face to the volunteers, by asking them to rate their own GH and OH on a Likert 5-point scale (1 – very bad, 2 – bad, 3 – median, 4 – good and 5 – very good).

The oral examination was conducted by a single experienced examiner, who was trained and calibrated (Cohen-Kappa of 0.80 was the minimal value). This examination was done under natural daylight and dental auxiliary light (OSRAM DECOSTAR), using a plain mirror #4 and a periodontal PDT sensor probe. The oral-health status was recorded based on the decayed, missing and filled teeth (DMFT) index and respective components (decayed teeth (DT), missing teeth (MT) and filled teeth (FT)), the Community Periodontal Index (CPI);³⁶ and the use of a prosthesis, if applicable.

Statistical analysis was performed using the IBM® SPSS® Statistics v.25 (IBM® Corporation). The mean values of the nDM2 and DM2 groups were compared using the Student's independent t-test, while categorical variables were compared using mostly the chi-square test. The binomial test was used to estimate the distribution of the controlled HbA1c value. The relationship of the perceived status of both GH and OH between groups was assessed using chi-square tests. The Bonferroni correction was used for proportion comparisons of more than two categories. The dependent variables of the perceived status of GH and OH were compared between groups based on the median scores of the categories of relevant covariates, using the nonparametric Mann-Whitney's test or the Kruskal-Wallis test. Whenever the Kruskal-Wallis test showed significant differences, the multiple comparisons were performed considering the Bonferroni correction. The significance level was set at 0.05 for all inferences.

Multivariable binary logistic regression (MLR) models (Wald backward stepwise method, $p=0.05$ for covariate inclusion and $p=0.10$ for exclusion) were used to predict associations (as risk or protective factors) between covariables identified in previous analyses and participants having "bad" or "very bad" SRH

or SROH. The quality of logistic regressions was evaluated using the area under the curve (AUC), and indicated the adjustment of the model of SRH and SROH to clinical variables.

Results

Most participants were female (56.9%), and the mean age was 63.9±12.8 years old. A significantly ($p=0.003$) higher percentage of women was in the nDM2 group (62.8%). The BMI higher classes – pre-obesity (47.5%) and obesity (37%), were significantly more frequent ($p<0.001$) in the DM2 group than in the nDM2. Significantly fewer smokers (7%) and a higher prevalence of clinical comorbidities were found in the DM2 group. A significantly greater part of the DM2 group ($p<0.001$) were standard^{34,37} controlled DM2 individuals (70%) (Table 1).

No differences were found in the reported daily oral hygiene between the nDM2 and DM2 groups. The DMFT index was significantly higher ($p=0.005$) in the nDM2 (17.7±8.3) than in the DM2 group (15.9±7.8), while dental caries experience was not significantly different. The DM2 group had a higher prevalence of periodontal disease (99.3% vs. 95.2% in the nDM2 group, $p=0.006$), with a higher severity status. The prevalence of periodontal pockets >3mm was 46% for the DM2 and 37.9% for the nDM2 group. Gingival recession prevalence was 95.7% for the DM2 vs. 87.7% for the nDM2 group ($p<0.001$). Total edentulism showed a significantly ($p<0.001$) higher prevalence in DM2 patients, being 1.86 times more prevalent (15.7%) than in the nDM2 group (Table 1).

Regarding the SRH and SROH results, described in Table 1, the DM2 group classified SRH significantly ($p<0.001$) worse than the nDM2, with "bad" or "very bad" perceptions. The nDM2 participants (Table 2) who rated SRH as "good" or "very good" (59.5%) also did it for SROH. Similarly, 53.1% of the DM2 patients classified both SRH and SROH as "very bad" or "bad." These results show a significant agreement in these classifications.

Table 3 reports the association between median and interquartile range and the socio-demographic and clinical variables. The higher the median value, the higher the perception of positive impacts on GH and OH for the DM2 and nDM2 groups. Although this was a rare condition, almost all DM2 and nDM2 participants with no caries experience (DMFT=0) classified their OH status as "good" or "very good," with only 1% of these DM2 patients classifying their OH as "median."

MLR identified variables significantly and independently associated with "bad" or "very bad" SRH or SROH in both groups (Table 4). In the nDM2 group, "bad" or "very bad" SRH was not associated with any GH clinical variable, while the CPI was found to be a risk factor for that outcome and having calculus was a significant risk factor of "bad" health ($OR=3.21$, 95%CI:1.03-9.99; $p=0.044$). In the DM2 group, the CPI was also found to be a risk factor for "bad" or "very bad" SRH ($p=0.015$), and arterial hypertension (HTA) and dyslipidaemia were other significant risk factors ($OR_{HTA}=16.62$, $p<0.001$ and $OR_{Dysl}=5.17$, $p<0.001$).

Regarding the "bad" or "very bad" SROH, the CPI was identified as a risk factor in the nDM2 group, together with calculus and pockets >4mm ($OR=3.55$, $p=0.049$, and $OR=4.32$, $p=0.025$, respectively). On the other hand, having at least 20 teeth was found to be a protective factor ($OR=0.22$, $p=0.001$), decreasing the chance of that outcome in 78%. In the DM2

Table 1. Demographic and oral clinic parameters between the study group – patients with type 2 diabetes mellitus (DM2) and the control group (nDM2)

		nDM2 n=323	DM2 n=343	P
Age (mean ± SD)		59.8 ± 14.2	67.8 ± 9.8	0.533*
Gender	Female	203 ^a (62.8%)	176 ^b (51.3%)	0.003
	Male	120 ^b (37.2%)	167 ^a (48.7%)	
General health				
BMI	Low weight or normal	125 ^a (38.7%)	53 ^b (15.5%)	<0.001
	Pre-obese	123 ^b (38.1%)	163 ^a (47.5%)	
	Obese	75 ^b (23.3%)	127 ^a (37.0%)	
Smoker		62 ^a (19.2%)	24 ^b (7.0%)	<0.001
Neuropathy		0 ^b (0%)	24 ^a (7%)	<0.001
Retinopathy		0 ^b (0%)	40 ^a (11.7%)	<0.001
Nephropathy		2 ^b (0.6%)	24 ^a (7.0%)	<0.001
HTA		109 ^b (33.7%)	184 ^a (53.6%)	<0.001
Dyslipidaemia		2 ^b (0.6%)	137 ^a (39.9%)	<0.001
Controlled Dyslipidaemia		16 ^b (5.0%)	299 (87.2%)	<0.001
HbA1c value	Controlled		240 ^a (70.0)	<0.001**
	Uncontrolled		103 ^b (30.0)	
Duration of DM2	≤5 years		120 (35.0)	0.767
	>5-10 years		109 (31.8)	
	>10 years		114 (33.2)	
Oral Health				
Daily oral hygiene	Yes	244 (75.5)	256 (74.6)	0.787
	in the morning	194 (60.1)	212 (61.8)	0.644
	after lunch	95 (29.4)	118 (34.4)	0.168
	at night	232 ^a (71.8)	217 ^b (63.3)	0.018
DT	n (%)	235 ^a (72.8)	215 ^b (62.9)	0.006
	mean ± SD	2.0 ^b ± 2.7	2.8 ^a ± 2.9	<0.001***
MT	n (%)	293 ^b (90.7)	323 ^a (94.7)	0.046
	mean ± SD	13.0 ^a ± 9.6	9.8 ^b ± 8.9	<0.001***
FT	n (%)	238 ^a (73.7)	213 ^b (62.3)	0.002
	mean ± SD	2.7 ^b ± 2.9	3.3 ^a ± 3.3	0.016***
DMFT	n (%)	319 (98.8)	336 (98.2)	0.585
	mean ± SD	17.7 ^a ± 8.3	15.9 ^b ± 7.8	0.005***
CPI	Normal	14 ^a (4.8%)	2 ^b (0.7%)	0.006
	BOP	57 (19.7%)	49 (18.0%)	
	Calculus	109 (37.6%)	96 (35.3%)	
	3 mm ≤ Pockets <6 mm	71 (24.5%)	65 (23.9%)	
	Pockets ≥6 mm	39 ^b (13.4%)	60 ^a (22.1%)	
Gingival recession		257 ^b (87.7%)	270 ^a (95.7%)	<0.001
Number of teeth ≥20		190 ^a (58.8%)	150 ^b (43.9%)	<0.001
Total edentulism		29 ^b (9.0%)	54 ^a (15.7%)	<0.001
Prosthesis rehabilitation need		26 ^b (8.0%)	50 ^a (14.6%)	0.008
Mandibular rehabilitation	None	231 ^a (71.5%)	212 ^b (61.8%)	0.007
	Removable	83 ^b (22.9%)	116 ^a (26.8%)	
	Fixed	9 (2.8%)	15 (4.4%)	
Maxillary rehabilitation	None	203 ^a (62.8%)	174 ^b (50.7%)	0.027
	Removable	101 ^b (26.6%)	144 ^a (35.6%)	
	Fixed	19 (5.9%)	25 (7.3%)	
Mandibular and maxillary rehabilitation	None	193 ^a (59.8%)	164 ^b (47.8%)	0.003
	Removable	106 ^b (32.8%)	147 ^a (42.9%)	
	Fixed	12 ^b (3.7%)	25 ^a (7.3%)	
	Removable and/or Fixed	12 (3.7%)	7 (2.0%)	
Self-Rated Perceived Health				
How do you rate your general health?	very bad or bad	83 ^b (25.7%)	140^a (40.8%)	<0.001
	median	126 (39%)	135 (39.4%)	
	good or very good	114^a (35.3%)	68 ^b (19.8%)	
How do you rate your oral health?	very bad or bad	133 (41.2%)	160 (46.6%)	0.041
	median	125 ^a (38.7%)	101 ^b (29.4%)	
	good or very good	65 (20.1%)	82 (23.9%)	

p-values according to the chi-square test, or * Independent t-test, or ** Binomial test *** Mann-Whitney test;

^{a,b} Different letters show significant differences according to the Bonferroni method (if chi-square test was performed) or according to the test applied. BMI – body mass index; HTA – arterial hypertension; DT- decayed teeth; MT – missing teeth; FT – filled teeth; DMFT – decayed, missing and filled teeth; CPI – Community Periodontal Index

Table 2. Association between different classes of SRH and SROH for patients with type 2 diabetes mellitus (DM2) and controls (nDM2)

	How do you rate your oral health?				p
	How do you rate your general health?	very bad or bad	median	good or very good	
nDM2	very bad or bad	46^a (34.6%)	27 ^{a,b} (21.6%)	10 ^b (15.4%)	<0.001
	median	56 (42.1%)	53 (42.4%)	17 (26.2%)	
	good or very good	31 ^b (23.3%)	45 ^b (36%)	38^a (58.5%)	
DM2	very bad or bad	85^a (53.1%)	30 ^b (29.7%)	25 ^b (30.5%)	0.001
	median	51 (31.9%)	47 (46.5%)	37 (45.1%)	
	good or very good	24 (15%)	24 (23.8%)	20 (24.4%)	

p-values according to the chi-square test. ^{a, b} different letters indicate significantly different counts according to the Bonferroni method.

Table 3. Statistics (median and interquartile range; the lower the median value, the lower the self-perceived positive impacts on health) regarding the self-perceived impacts (from very bad=1 to very good=5) of general health and oral health for the control (nDM2) and the DM2 groups, considering several socio-demographic and clinical (general health and oral health) variables.

		How do you rate the perceived status of your general health?				P	How do you rate the perceived status of your oral health?			
		nDM2		DM2			nDM2	DM2		P
		n	Me (P25-P75)	n	Me (P25-P75)		Me (P25-P75)	Me (P25-P75)		
Gender	Female	203	3 ^a (2-4)	176	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-3)	0.321	
	Male	120	3 ^a (3-4)	167	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-4)	0.894	
			0.353		0.869		0.182	0.365		
Age	< 65 years	196	3 ^a (3-4)	114	3 ^b (2-3.25)	0.002	3 (2-3)	3 (2-3.25)	0.669	
	≥ 65 years	127	3 ^a (2-4)	229	3 ^b (2-3)	0.002	3 (2-3)	3 (2-3)	0.457	
			0.081		0.159		0.987	0.947		
General Health										
BMI	Low weight or normal	125	3 (3-4)	53	3 (2-4)	0.050	3 (2-3)	3 (2-3.5)	0.595	
	Pre-obese	123	3 ^a (3-4)	163	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-3)	0.532	
	Obese	75	3 (2-4)	127	3 (2-3)	0.293	3 (2-3)	3 (2-3)	0.560	
			0.115		0.129		0.493	0.970		
Smoker	No	261	3 ^a (3-4)	319	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-4)	0.963	
	Yes	62	3 (2-4)	24	3 (2-4)	0.689	3 (2-3)	2 (1-3)	0.013	
			0.910		0.355		0.731	0.108		
Neuropathy	No	323	3 ^a (2-4)	319	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-3)	0.764	
	Yes	0		24	2 (1-3)	n.a.		2 (1.25-3)	n.a.	
			n.a.		0.504		n.a.	0.267		
Retinopathy	No	323	3 ^a (2-4)	303	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-3)	0.917	
	Yes	0		40	2 (1-2)	n.a.		2 (2-3)	n.a.	
			n.a.		0.148		n.a.	0.416		
Nephropathy	No	321	3 ^a (2-4)	319	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-3)	0.620	
	Yes	2	3 (3-3)	24	2 (1-3)	0.302	2 (2-2)	2 (1.25-3)	0.677	
			0.760		0.231		0.863	0.906		
HTA	No	214	3 (3-4)	159	3 ^A (2-4)	0.638	3 (2-3)	3 (2-4)	0.758	
	Yes	109	3 ^a (2-4)	184	2 ^{Bb} (2-3)	<0.001	3 (2-3)	3 (2-3)	0.753	
			0.994		<0.001		0.898	0.706		
Dyslipidaemia	No	306	3 (2-4)	44	3 ^A (2-4)	0.369	3 (2-3)	3 (2-3)	0.969	
	Yes	16	3 (2-3.75)	299	3 ^B (2-3)	0.186	2 (2-3)	3 (2-3)	0.381	
			0.532		<0.001		0.641	0.994		
Controlled dyslipidaemia	No	319	3 (2-4)	206	3 ^A (2-4)	0.150	3 (2-3)	3 (2-3)	0.726	
	Yes	2	2.5 (2-3)	137	2 ^B (2-3)	0.714	2.5 (2-3)	2 (2-3.5)	0.950	
			0.768		<0.001		0.857	0.847		
HbA1c value	Controlled			103	2 ^B (2-3)	n.a.		2 (2-3)	n.a.	
	Uncontrolled			240	3 ^A (2-3)	n.a.		3 (2-3.75)	n.a.	
					<0.001			0.178		
Duration of DM2	≤5 years			120	3 ^A (2-3)	n.a.		3 ^A (2-4)	n.a.	
	>5-10 years			109	3 ^A (2-3)	n.a.		3 ^A (2-3.5)	n.a.	
	>10 years			114	2 ^B (2-3)	n.a.		2 ^B (2-3)	n.a.	
					0.027			0.015		

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Table 3. Statistics (median and interquartile range; the lower the median value, the lower the self-perceived positive impacts on health) regarding the self-perceived impacts (from very bad=1 to very good=5) of general health and oral health for the control (nDM2) and the DM2 groups, considering several socio-demographic and clinical (general health and oral health) variables. (continuation)

		How do you rate the perceived status of your general health?					How do you rate the perceived status of your oral health?				
		nDM2		DM2		p	nDM2		DM2		p
		n	Me (P25-P75)	n	Me (P25-P75)		Me (P25-P75)	Me (P25-P75)			
Oral Health											
Daily oral hygiene	No	79	3 ^a (2-4)	87	3 ^b (2-3)	0.041	2 ^B (2-3)	3 (2-3)	0.052		
	Yes	244	3 ^a (2-4)	256	3 ^b (2-3)	<0.001	3 ^A (2-3)	3 (2-3.75)	0.081		
		0.708		0.697			<0.001	0.504			
DT	DT=0	88	3.5 (2.25-4.75)	6	3.5 (1-4)	0.001	3 (2-3)	2 (1-4)	0.447		
	DT>0	235	3 ^a (2-4)	336	3 ^b (2-3)	<0.001	3 (2-3)	3 (2-3)	0.863		
		0.926		0.177			0.662	0.192			
MT	MT=0	30	3 ^a (2-4)	129	2 ^{Bb} (2-3)	0.314	4 ^A (3-4)	4 (4-5)	0.090		
	MT>0	293	3 ^a (2.75-4)	213	3 ^{Ab} (2-3.5)	<0.001	3 ^B (2-3)	3 (2-3)	0.501		
		0.234		0.005			<0.001	<0.001			
FT	FT=0	85	3 (3-4)	18	3 (2-4)	<0.001	2 (1-3)	2 ^B (1-3)	0.184		
	FT>0	238	3 ^a (2-4)	323	3 ^b (2-3)	0.003	3 (2-3)	3 ^A (2-4)	0.198		
		0.243		0.078			0.147	0.018			
DMFT	DMFT=0	4	3 (2-4)	127	3 (2-3)	0.610	5 ^A (4.25-5)	4.5 ^A (3.75-5)	0.476		
	DMFT>0	319	3 ^a (3-4)	215	3 ^b (2-3)	<0.001	3 ^B (2-3)	3 ^B (2-3)	0.448		
		0.926		0.177			<0.001	0.003			
CPI	Normal	14	4 (2.8-4)	2	3.5 ^{ABC} (3-0)	1.000	4 ^{AB} (2.8-4)	4.5 ^{AB} (4-5)	0.350		
	BOP	57	3 (3-4)	49	3 ^A (2-4)	0.154	3 ^{AB} (3-4)	3 ^A (3-4)	0.856		
	Calculus	109	3 (2-4)	96	3 ^B (2-4)	0.837	3 ^{AB} (2-3)	3 ^{Aa} (2-4)	0.031		
	3 mm ≤ Pockets<6 mm	71	3 (3-4)	65	3 ^B (2-3)	0.057	3 ^{AB} (2-3)	3 ^A (2-4)	0.061		
	Pockets ≥6 mm	39	3 (2-4)	60	2.5 ^C (2-3)	0.064	2 ^B (2-3)	2 ^B (2-3)	0.843		
		0.129		0.034			<0.001	<0.001			
Gingival recession	No	36	3 (2.3-4)	12	2 (1.3-3)	0.055	2 ^B (2-3)	3 (2-4)	0.112		
	Yes	257	3 ^a (3-4)	270	3 ^b (2-3)	<0.001	3 ^A (2-3)	3 (2-4)	0.551		
		0.814		0.152			0.031	0.611			
Number of teeth ≥20	No	133	3 ^a (2-4)	192	3 ^{Bb} (2-3)	<0.001	2 ^B (1-3)	2 ^B (1-3)	0.341		
	Yes	190	3 ^a (2.8-4)	150	3 ^{Ab} (2-4)	0.016	3 ^{Ab} (2-4)	3 ^{Aa} (3-4)	0.002		
		0.208		0.001			<0.001	<0.001			
Total edentulism	No	294	3 ^a (3-4)	288	3 ^{Ab} (2-3)	<0.001	3 ^A (2-3)	3 ^A (2-4)	0.341		
	Yes	29	3 ^a (2-4)	54	2 ^{Bb} (2-3)	0.010	2 ^B (1-2)	1 ^B (1-2)	0.072		
		0.186		<0.001			<0.001	<0.001			
Prosthesis rehabilitation need	No	297	3 ^a (3-4)	292	3 ^{Ab} (2-3)	<0.001	3 ^A (2-3)	3 ^A (2-4)	0.372		
	Yes	26	3 (2-4)	50	2 ^B (2-3)	0.018	2 ^{Ba} (1-2.3)	1 ^{Bb} (1-2)	0.041		
		0.140		<0.001			<0.001	<0.001			
Mandibular rehabilitation	No	231	3 ^a (3-4)	212	3 ^{Ab} (2-3)	0.001	3 ^A (2-3)	3 ^A (2-4)	0.092		
	Removable	83	3 ^a (2-4)	116	3 ^{Bb} (2-3)	<0.001	2 ^{Ba} (2-3)	2 ^{Bb} (1-2)	0.040		
	Fixed	9	3 (2-4)	15	2 ^{AB} (2-4)	0.640	3 ^{Aa} (3-4)	3 ^{Aa} (2-4)	0.482		
		0.770		<0.001			0.014	<0.001			
Maxillary rehabilitation	No	203	3 ^a (2-4)	174	3 ^{Ab} (2-4)	0.009	3 ^A (2-4)	3 ^A (2-4)	0.083		
	Removable	101	3 ^a (2-4)	144	2.5 ^{Bb} (2-3)	<0.001	2 ^{Ba} (2-3)	2 ^{Bb} (1-3)	0.036		
	Fixed	19	3 (3-4)	25	3 ^A (2-3)	0.071	3 ^{Aa} (3-4)	3 ^{Aa} (3-4)	0.397		
		0.650		0.012			<0.001	<0.001			
Mandibular and maxillary rehabilitation	No	193	3 ^a (2-4)	164	3 ^b (2-3.75)	0.009	3 ^A (2-4)	3 ^A (2-4)	0.142		
	Removable	106	3 ^a (2-4)	147	3 ^b (2-3)	<0.001	2 ^B (2-3)	2 ^B (1-3)	0.096		
	Fixed	12	3 (2.25-4)	25	3 (2-3.5)	0.575	3 ^A (3-4)	3 ^A (3-4)	0.835		
	Removable and fixed	12	3 (3-4)	7	3 (2-3)	0.083	3 ^{AB} (2.25-3)	3 ^{AB} (2-4)	0.837		
		0.454		0.086			<0.001	<0.001			

^{A,B,C} different cap letters indicate significant differences regarding the variable categories within non-DM2 or DM2 individuals, according to the Mann-Whitney test with Bonferroni adjustment. ^{a,b} different small-cap letters indicate significant differences regarding the non-DM2 and DM2 individuals within the variable category, according to the Mann-Whitney test. BMI – body mass index; HTA – arterial hypertension; DT – decayed teeth; MT – missing teeth; FT – filled teeth; DMFT – decayed, missing and filled teeth; CPI – Community Periodontal Index

Table 4. Risk and protective factors (multivariable logistic regression) independently associated with “bad” or “very bad” self-rated perception impacts of GH or OH, for nDM2 and DM2 participants.

Variables	Self-rated perceived general health				Self-rated perceived oral health			
	nDM2		DM2		nDM2		DM2	
	p	OR (95%CL)	p	OR (95%CL)	p	OR (95%CL)	p	OR (95%CL)
Smoker (yes)							0.065	4.63 (0.91-23.54)
Controlled DM2 (yes)								
HTA (yes)			<0.001	16.62 (7.01-39.43)				
Dyslipidaemia (yes)			<0.001	5.17 (2.07-12.90)				
Daily oral hygiene (yes)					0.056	0.38 (0.14-1.03)		
Total edentulism (yes)								
At least one missing tooth (yes)					0.051	2.31 (0.99-5.38)	0.003	7.55 (2.03-28.07)
Number of total teeth ≥20					0.001	0.22 (0.09-0.56)	<0.001	0.09 (0.04-0.18)
CPI (normal)	0.099	1	0.015	1	0.050	1		
CPI (bleeding)	0.375	1.71 (0.52-5.56)	0.225	7.09 (0.30-168.54)	0.332	1.87 (0.53-6.59)		
CPI (calculus)	0.044	3.21 (1.03-9.99)	0.192	7.98 (0.35-180.63)	0.049	3.55 (1.01-12.47)		
CPI (pockets ≥4 mm)	0.123	2.43 (0.79-7.50)	0.057	21.11 (0.913-488.37)	0.025	4.32 (1.20-15.55)		
Constant	0.594	0.75	0.026	0.026	0.133	4.20	0.336	2.04
Variables entering the first step of the analyses:	Daily oral hygiene (at night) CPI (calculus)		Controlled DM2 HTA Dyslipidaemia Daily oral hygiene (yes) Total edentulism Number of teeth ≥ 20 DMFT >0 MT >0 Removable prosthesis		Daily oral hygiene (yes) Daily oral hygiene (in the morning) Daily oral hygiene (at night) MT >0 CPI (calculus or pockets) Number of teeth ≥ 20 Total edentulism Prosthesis rehabilitation need Removable prosthesis		Duration of DM2 Smoker MT > 0 FT > 0 DMFT >0 Prosthesis rehabilitation need Removable prosthesis Number of teeth ≥ 20 Total edentulism	
Quality of the model								
This model has a correct prediction of (%)	64.8%		80.4%		81.0%		80.1%	
Area under the ROC curve	p	AUC ROC (95%CL)	p	AUC ROC (95%CL)	p	AUC ROC (95%CL)	p	AUC ROC (95%CL)
	0.027	0.58 (0.51-0.65)	<0.001	0.83 (0.77-0.88)	<0.001	0.77(0.71-0.84)	<0.011	0.81 (0.75-0.86)

OR – odds ratio; HTA – arterial hypertension; DT- decayed teeth; MT – missing teeth; FT – filled teeth; DMFT – decayed, missing and filled teeth; CPI – Community Periodontal Index

group, having at least one tooth missing was a risk factor for “bad” or “very bad” SROH (OR=7.55, p=0.003) while having at least 20 teeth was a protective factor (OR=0.09, p<0.001), decreasing the chance of that outcome in 91%.

The AUC values obtained for some models (AUC higher than 80%, p<0.010) showed a good adjustment to predict a “bad” or “very bad” SRH in the DM2 group and SROH in the nDM2 and DM2 groups. Thus, a potential clinical application of these predictive models can be considered. On the other hand, that cannot be said for SRH in the nDM2 group, which showed a reasonable adjustment (AUC = ~65%, p=0.027) (Table 4).

Discussion

The present study confirms the hypothesis that SRH and SROH were perceived differently by DM2 and nDM2 participants. The DM2 group had worse SRH and SROH than the nDM2, and OH was generally self-rated worse than GH regardless of the presence of DM2.

The sample showed a significantly higher frequency of women in the nDM2 group and men in the DM2 group, which is similar to the study by Liu,³⁸ and may be justified by women being more likely to go to health centres than men. Like in

other studies,^{39,40} the DM2 group had significantly more participants in the heavier classes of BMI than the nDM2 group. However, no relation was found between MT and obesity, as described by Nascimento.⁴¹ Regarding SRH, the nDM2 participants with a pre-obese condition presented better health perception than DM2 participants. Similarly to other studies,^{8,42} the DM2 group had significantly fewer smokers, and tobacco use was significantly different among the DM2 participants, probably due to a perception of its negative impacts on OH.

There were no significant differences in daily oral hygiene habits between groups. As reported by other authors, the periodontal condition was significantly better in the nDM2 than in the DM2 group.^{13,14,38} The most severe forms of periodontitis in DM2 participants, with more gingival recession and periodontal pockets >3mm, had a more negative impact on SRH and SROH.

Regarding associations between SRH and SROH, a better concordance was found in the nDM2 group, whereas DM2 participants reported significantly more negative impacts by rating GH and OH as “very bad” and “bad” more often. As theorized by Petersen³³ and reported in other studies,^{1,30-32,44} DM2 patients showed a poorer perception of health than nDM2 individuals, which explains why the “median” OH classification was significantly more reported in controls than in DM2 patients. The same goes for the opposite extreme of perception, as nDM2 participants rated OH and GH as “good” or “very good” more often. Regarding the socio-demographic variables, there were no significant differences in SRH and SROH.

Individuals with an HbA1c value indicating a lack of control of DM2 showed better SRH, probably because they did not value their health status adequately as they did not feel the complications of DM2 significantly affecting them. The other DM2 complications probably justified a worse self-perception of GH and OH by those who had an older diagnosis comparing to those with up to 10 years of disease.

DM2 patients with HTA or dyslipidaemia showed worse SRH, while those who had normotension showed a significantly better perception of GH. None of these systemic characteristics revealed a significantly different impact on SROH between groups.

Regarding OH variables, including daily oral hygiene, DT>0, MT>0, FT, DMFT>0, <20 teeth in the mouth, total edentulism and need of prosthesis rehabilitation, the latter was associated with a higher perception of GH as “bad” or “very bad” in DM2 patients. Within the DM2 group, a severe CPI classification, <20 teeth or total edentulism and no prosthesis rehabilitation were associated with a worse perception of GH. These data support the concept of OH influencing GH and the quality of life of individuals.^{1,3,12,22,24}

The absence of daily oral hygiene habits and calculus showed more negative impacts only among nDM2 participants. However, the presence of caries lesions was not significant. Calculus (had lower medians than the “normal” state), MT>0 and DMFT>0 showed significantly negative impacts in both groups, and FT>0 only in the DM2 group. Total edentulism, the absence of fewer than 20 teeth and the need of prosthetic rehabilitation had negative impacts with a significantly worse perception of OH. Oral rehabilitation is always related to removable prostheses (independently of being maxillary,

mandibular or both), and these showed a more negative impact on GH and OH.

The MLR showed that the factors with greater relevance for a worse perceived GH were the presence of calculus and oral hygiene at night for the nDM2 group. As for the DM2 group, those factors were HTA, dyslipidaemia, total edentulism and at least one missing tooth, although this was a protective factor (OR=0.45, IC95%: 0.20-0.99) when DM2 was controlled.

Regarding SROH in the nDM2 group, the MLR showed that having at least 20 teeth represented a protective factor (OR=0.22, IC95%:0.089-0.556) and the presence of calculus or a periodontal pocket >3.5mm had a negative impact. Daily oral hygiene “in the morning” or “at night”, MT>0 and total edentulism, when included in the model, were found to be predictor factors for a negative impact on OH in nDM2 participants.

Finally, the MLR showed that the predictors of a negative SROH in DM2 patients were: the duration of DM2, smoking habits, MT>0, FT>0, DMFT> 0, total teeth <20 and total edentulism. This estimated model has a correct prediction of 80.1%.

The fact that the pairing was performed only from an analytical perspective and not by pairing each participant could be a limitation of the study. However, as Pierce⁴⁴ pointed out in his methodological review article, when there are no problems with data dispersion, a standardized statistical analysis for a case-control study can be performed.

Because this study is based on a clinical sample obtained in a primary public health centre that follows the most diabetic patients for disease monitoring in Portugal, the results should be generalized to the overall population with care.

Conclusions

The present study confirms the hypothesis that DM2 patients had a worse SRH and SROH than individuals without DM2. Both groups perceived GH and OH differently, and OH was generally self-rated worse than GH regardless of having DM2.

The prevalence of oral pathologies in both groups was high. However, DM2 patients presented fewer caries lesions, more extracted teeth, more FT, and few were rehabilitated. The presence of more advanced forms of periodontal disease (pockets) affected the SRH and SROH negatively. Simultaneously, an older diagnosis of DM2 and tobacco use induced the greater perception of negative impacts on OH among DM2 patients.

The most developed primary health centres should include access to oral care in order to monitor OH regularly, as well as other macro and microvascular complications in DM2 patients. Better attention centred in the OH patient by healthcare units is needed, and the access to OH professionals could be a way of improving diabetic patient's GH and OH.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics com-

mittee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflict of interest

The authors have no conflicts of interest to declare.

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